

THE INLAND WATERWAY

The historic Gallatin Report on Roads, Canals, Harbors and Rivers, presented to Congress on April 4, 1808, defined a concept of internal improvement which, in its broad terms has remained up to modern times as a virtual statement of national policy. But President Jefferson's Secretary of the Treasury was ahead of his time in American government. The Congress of his day was not ready to spend 20 million dollars of the peoples' money on a ten year program of road and canal building. It devolved upon private enterprise and local government to actualize the concepts engendered in Mr. Gallatin's proposals.

The first part of the three part program recommended in the Secretary's report proposed the creation of an Inland Waterway from Massachusetts to North Carolina, using existing bays and rivers linked by a system of canals. Practical benefits would obviously accrue to the national defense beyond the provision of a protected trade route for coast-wise shipping. The report's specific recommendations included federal financial support for the Chesapeake and Delaware Canal, a privately promoted enterprise incorporated in 1799, which had made three unsuccessful attempts to begin construction. This important link did eventually obtain substantial government assistance in 1822 and was finished in 1829.

The Delaware and Raritan Canal

This other "logical" segment of a national water route partially within the purview of the District was not opened for navigation until 1834, after undergoing financial difficulties typical of the period. The Delaware

and Raritan Canal, connecting the Delaware River with Raritan Bay and the Port of New York, materialized as a consequence of commercial logic rather than as a part of an Inland Waterway plan. Coal from Pennsylvania mines, carried by the Schuylkill Navigation¹ to the Delaware River at Philadelphia, had to be reloaded into seaworthy vessels for the long trip to New York via Cape May and the Ocean. By canal, the 43 miles of the inside route between Bordentown and New Brunswick could be traveled by open barges which had been loaded at the mines, saving almost 200 miles and the need to transfer cargoes. Ill-starred from the beginning, the D & R had to compete with railroads from the day it was chartered. On that day, Feb 4, 1830, the State of New Jersey granted a charter also to the Camden and Amboy Railroad, which built its line parallel to the canal route. A peculiar arrangement was negotiated by which the two companies shared fiscal matters but retained separate corporate identities. The State of New Jersey, in a questionable bargain with the two companies, granted them a virtual monopoly for transportation between Philadelphia and New York in exchange for the payment of lucrative transit duties.

The physically best-endowed of American canals for many of its earlier years, the Delaware and Raritan might have become hugely profitable, but for its unfortunate involvement in Railroad and State transportation deals. Chief engineer for its construction was Canvass White, then considered the country's foremost engineer. Backed by ample funds and a store of experience gained from his work on the Erie and other projects, White built an almost trouble-free waterway. With only 14 locks, an ample water supply

and the largest channel section except that of the Chesapeake and Delaware, the Delaware and Raritan was the key link for freight traffic to New York Harbor from Chesapeake Bay, the Susquehanna hinterland and the Pennsylvania coal fields. Exclusively a freight carrier, its commerce was preponderantly "through" hauls of coal cargoes. The channel was enlarged in 1846 to meet competition of the Railroad and the canal attained its peak in 1859 when it carried 1,699,101 tons, of which 1,372,109 were anthracite coal.

Having built its business on a specialized commodity, the D & R was dependent on the flow of coal barges from the Pennsylvania mines, especially via the Schuylkill Navigation. So the fortunes of the Schuylkill Navigation and the D & R were inextricably entwined. Those fortunes began to deteriorate with the 1850 Schuylkill floods which wrecked 23 dams, and continued to slump as the Reading Railroad took over more of the coal transport business. The year 1869 was catastrophic. A miner's strike halted coal shipments and a severe drought reduced flows to levels too low for navigation. In September rain fell in exorbitant amounts, producing the greatest flood the Schuylkill Valley had known and nearly wiping out the Navigation Company's works. A year later the Schuylkill Navigation came under the control of the Reading Railroad.

Across the Delaware things fared little better. In 1871, the Pennsylvania Railroad leased the Camden and Amboy Railroad and with it took over the Delaware and Raritan Canal. In rivalry with the Reading, the Pennsylvania Railroad prohibited use of the D & R for transport of coal from the Schuylkill

mines, in one stroke curtailing the canal's business by a million tons annually. Both Companies allowed their water routes to decline, diverting the freight business to their rail lines. The Schuylkill suffered disastrously; unable to recover, it had by 1905 ceased carrying all freight traffic.

Though neglected, the Delaware and Raritan survived and remained a fine canal. Never seriously impaired by floods or droughts, its setbacks stemmed principally from the fancies and foibles of its controllers, rather than from a faulty physical plant. It carried 1,200,000 tons in 1889 and was still doing business, though at a loss, when in 1895 a prominent group of Philadelphians started a movement to promote construction of a deep draft canal between the Delaware River and the Atlantic Ocean.

New Jersey Ship Canal ("The Missing Link")

The Canal Commission of Philadelphia was created by ordinance of Select and Common Councils of the City of Philadelphia under date of July 2, 1894. The Commission, originally chaired by Mayor Edwin S. Stuart,² listed among its members some of the most prestigious names³ in Philadelphia public life. N. H. Hutton, Engineer of the Harbor Board of Baltimore, was appointed Consulting Engineer and Professor L. M. Haupt was engaged as the Engineer in Charge of Surveys. The sum of \$10,000 was appropriated for preliminary surveys and studies. The petition requesting the first public hearing had cited Baltimore's efforts to secure a ship channel to the sea and the urgent necessity of increasing the transportation facilities of Philadelphia port and city. Concurrently, a board was

Proposed Trans-Jersey Ship Canal—1896.

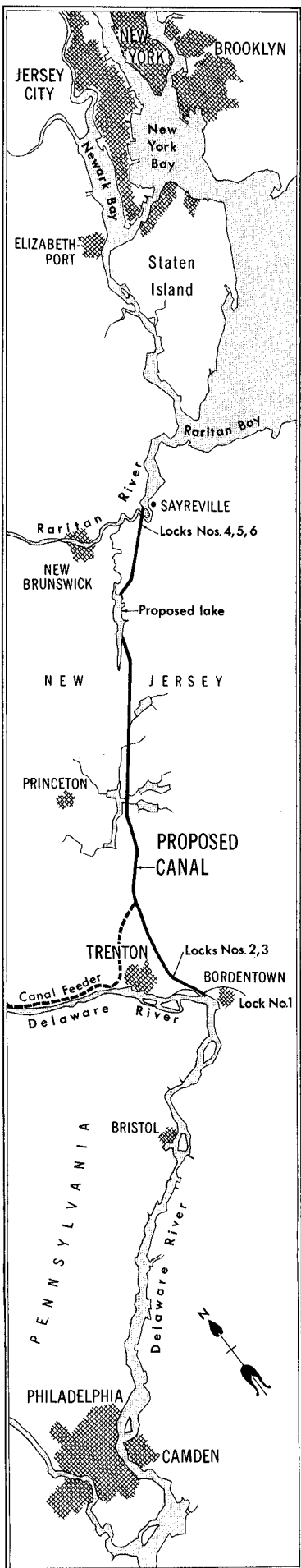
In 1894, A survey party of 17 Corps of Engineers personnel ran lines for canal and feeder—59 miles in 51 days.

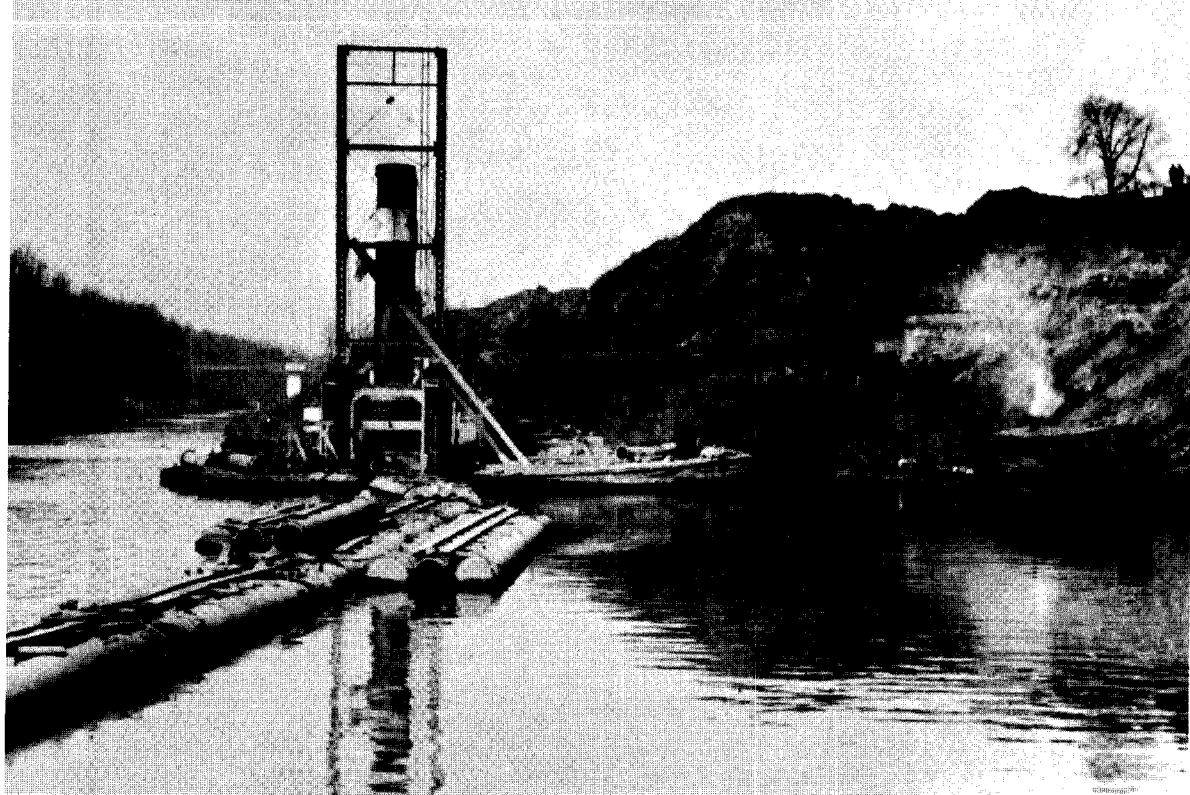
On the map, the route appeared to its proponents as logical and necessary as that of the Chesapeake and Delaware Canal, which was then receiving favorable consideration for development by the National Government.

Its undenied merits were offset by obstacles of logistics and ecology and by opponents in the power struggle which was shaping the transportation patterns of the period.

appointed by the President of the United States to determine the most feasible route for a deep draft Chesapeake and Delaware Canal.

In a combined report submitted to Philadelphia City Councils on June 4, 1895 Hutton and Haupt set forth an overall configuration for a one-level lock canal with facilities for transiting all classes of vessels including warships. The route under consideration stipulated improvement of the Delaware River Channel from Philadelphia to Bordentown, where the canal proper would start. From there the canal would proceed nearly due northeast across New Jersey to the Raritan River in the vicinity of Sayreville. River to river, the canal was to be 31.4 miles long. The plan generally ignored the old Delaware and Raritan route, which was 11 1/2 miles longer and meandered considerably. Three locks at each end would provide a total mean lift of 56 feet. Alternative prism designs were offered; one for a depth of 20 feet, bottom width 96 feet and a surface width of 150 feet; the other for a 28-foot depth and widths of 100 feet at bottom and 184 feet at the surface. Proposed toll rates were: 20 cents per ton for the 20-foot channel; 30 cents per ton for the 28-foot channel. Estimated construction costs for the two plans, respectively: \$14,264,600 and \$23,894,700. Hutton's report gave figures for mileage saved by the inside route: Philadelphia to Battery, N.Y., 182 miles; time saved by average steamer, one way: 12.4 hours. Water supply was to be obtained entirely from the Delaware River by "construction of a suitable dam and feeder." On the project map this appears to be





Chesapeake and Delaware Canal conversion to sea-level waterway, 1924. Hydraulic pipeline dredge is excavating in the Deep Cut east of Summit Bridge.

located on the course of the old D & R feeder, which ran from Raven Rock to Trenton, a distance of 22 miles. The old feeder, built 1832-34, was 60 feet wide, 6 feet deep and navigable through the first quarter of the twentieth century. The report notes that the survey party, staffed by 17 Corps of Engineers personnel, "prosecuted the work rapidly, over 59 miles having been run in 51 working days."

The traditional opponent of canals — the Railroad—fought any attempt to realize a trans-Jersey link for the Intracoastal Waterway. Among other obstacles cost was always paramount. Maintenance of the huge water supply, estimated by Prof. Haupt to be 7,677,366,000 cubic feet per annum for passage of 10 million tons of traffic, posed logistical problems which prompted many persons to start thinking in terms of a sea-level canal. Meanwhile, the Special Board headed by Chief of Engineers General Casey, was preparing a report on the proposed Chesapeake and Delaware Ship Canal and

would, in a few months, recommend purchase of the old C & D Lock Canal and its conversion to a toll-free sea level waterway.

A new group, the Atlantic Deeper Waterways Association, founded in 1907, took up the cudgels for the Trans-Jersey Ship Channel, which they dubbed "The Missing Link". At their Baltimore convention of 1908 resolutions were drawn emphasizing the needs of commerce, risks to human life accompanying the outside route and benefits to the Nation in case of war. It was also resolved "*That the canals should be dugged in any case by the Federal Government --- because the Government alone has authority over navigable waters --- because all the canals should be free ---*" The Philadelphia Record, a leading daily newspaper, deplored the railroads' destructive waterways practice of acquisition and compulsory disuse⁴. "*... It has been deemed good policy on the part of the Railway Companies as far as possible to do away with the rivalry of water carrying. To this end vast sums of money have been spent*

in acquiring control of canals and water lines... The adoption of such a destructive policy was perhaps natural enough at the beginning, but it was and is a stupendous blunder.... To create a new facility for traffic is to create new traffic. To destroy an existing facility brings no answering advantage."

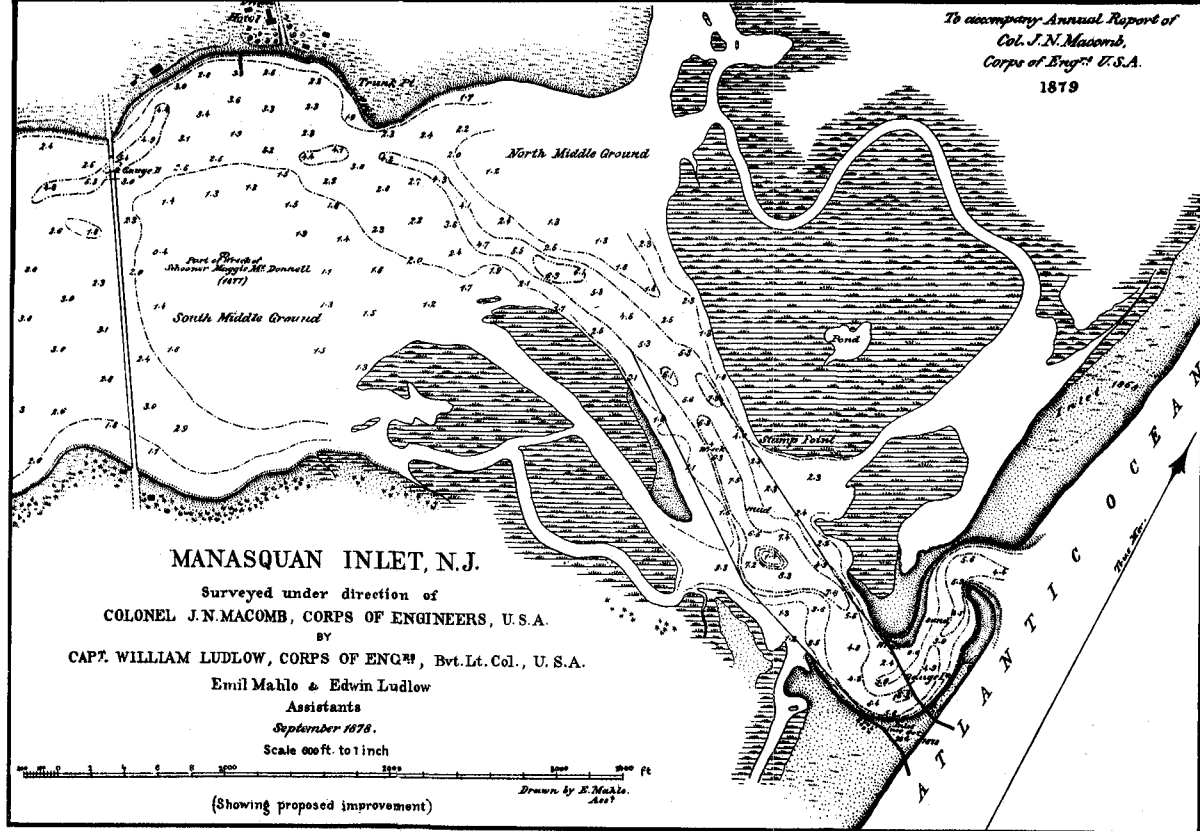
Advocates of the "Missing Link" propounded no new arguments in the 30 years subsequent to the founding of the Atlantic Deeper Waterways Association. But the old issues were kept alive and before the attention of Congress. In a report of 1912, cost of the project was estimated at 20 to 45 million dollars. In 1937 estimated costs were 65 to 85 millions.⁵ By 1942 the quoted figure was 187 million dollars⁶, based on studies for a revised channel concept. This plan proposed a summit level at an elevation of 10 feet above mean low water, requiring a deeper excavation and consequent penetration of the area's waterbearing sands. Objections were raised by New Jersey water supply authorities, who thought that salt intrusion from the Sayreville entrance would ruin ground water supplies and contaminate the Delaware River. A review report directed in June 1934 by the House River and Harbor committee defined the problems and sought solutions relevant to the proposed project. These studies, undertaken by the New York District, Corps of Engineers were incomplete due to lack of funds. Recommendations included construction of a dam on the West Branch of the Delaware River at Cannonsville, New York from which substantial releases would furnish ample flows and generating power to pump Delaware River water into the Bordentown

locks; reservoirs fed by the Raritan drainage area would augment the supply and furnish a sufficient current volume to operate the locks and carry out a system of flushings which would obviate salinity intrusion. A large scale model of the proposed canal and locks was set up at the Corps' Waterways Experiment Station at Vicksburg, Mississippi. The empirical conclusions of a large number of scale lockages predicated the above recommendations.

The "Missing Link" is still a subject of sporadic interest and missionary enthusiasm. Its value as a strategic military tool declines as modern weaponry advances beyond traditional restraints of time and space. During World War II there was some thought to justify the project by using the valuation of boats and cargo lost to enemy submarine action between Norfolk and New York harbor. If a report was made it must have been confidential and possibly less than persuasive. The argument for safe passage of ships also loses emphasis as technology continues to contribute to safer navigation. An editorial campaign was undertaken several years ago to stimulate interest in restoration of the old Delaware and Raritan Canal as a route to serve the East Coast's growing numbers of pleasure craft.

New Jersey Intracoastal Waterway

That segment of the Inland Waterway⁷ which comes under the District's supervision begins, at its northern end, where the route enters Manasquan Inlet from the Atlantic Ocean, at the mouth of the Manasquan River. The channel penetrates the lower basin of the Manasquan for two and one half miles, then



turns southeastward and passes through the two-mile long Point Pleasant Canal to join with Barnegat Bay at Bay Head.

Plans for a canal to connect the waters of the Manasquan River and Barnegat Bay were projected around 1839. A state charter was obtained, Commissioners appointed and funds raised by public subscription. The survey, run across the littoral marsh, revealed a four foot differential in water levels of the terminals, predicated the need for a canal with two locks. An assessment of costs and potential assets persuaded the commissioners that the project was financially unfeasible and should be abandoned.

Forty years later a survey and examination of Manasquan River was reported to the Chief of Engineers by Captain William Ludlow of the Philadelphia Engineer Office. The 1879 chart accompanied the report, which included a project plan and cost estimates for improving the river, opening an inlet and constructing protective jetties. The natural inlet was an intractable, S-shaped gut, scoured out of the sand beach, separated from the ocean by a sand bar 80 to 100 feet wide. The constantly shifting sands made the channel unpredict-

able, navigation hazardous. Occasionally, with westerly winds prevailing, the bar was flooded to sufficient depth to permit the entrance of shallow draft vessels. At times the upper section of the gut became congested, causing stagnation of the river, consequent fish kill and noxious living conditions for the local inhabitants.

Captain Ludlow's plan called for dredging a channel through the bar perpendicular to the coastline and constructing jetties to extend offshore, wing fashion, about 100 feet. Creosoted timber piles were to be driven by water jet, the structure to be sand-filled and capped with stone. Survey lines run for the report failed to corroborate an appreciable disparity of levels between mean high water of the bay and mean low water of the river, which had been reported in 1839. Captain Ludlow dismissed the relevance of a canal, in any event a canal with locks, but emphasized the expediency of the inlet project as providing a needed harbor of refuge for vessels navigating the "long reach of unbroken shore of New Jersey."

In the second session of 1879, Congress appropriated \$12,000 for commencement of

Capt. William Ludlow



the Manasquan River improvement. In the next two years additional sums were appropriated for a total of \$39,000. In 1883 work was suspended. Gaps in the records allow some conjecture as to the actual extent of operations, since the project cost was estimated at \$52,120. Certainly, an inlet was dug and lined with timber piling; dredging in Manasquan River, as originally proposed, was probably curtailed and snagging operations may have gone by the board as often happened with the early river projects.

Sand, swept northward with the littoral drift, rounded the south jetty and obstructed the inlet, which was frequently closed in the early 1900's. A project of 1933 provided new jetties of dumped stone; inshore bulkheads of steel sheet pile were installed in 1937. Rehabilitation of the bulkheads in substantial amounts was carried out in 1939 and 1955; minor patching was done in 1952, 1957 and 1961. Progressive deterioration of the steel piling, due to galvanic action and the corrosive effects of salt water and air, occasioned an examination in 1962; subsequent study offered alternate plans for rehabilitating the bulkheads by installation of steel sheet pilings, jetty-type stone structures or pretensioned prestressed concrete sheet piles.

The last method was adopted (the first of its kind in the District) and installed in 1964-65. The 1 1/2 to 7 1/4 ton slabs were placed behind the existing piles and tied in with existing tie rods. Every detail was studied for optimum results with maximum economy. Extensive core sampling was ruled out by the stringency of the budget. Historically, the materials most resistant to penetration were sand and soft clay. Piles for the

north bulkhead were jetted into place without undue difficulty, but the south bulkhead required deeper penetration, and here tough resisting clay was encountered. The blunt pile tips were not designed for percussion driving; water jets were ineffective in penetrating the stiff bottom material. Iron wedge shoes for the pile tips were considered, but not adopted for cost reasons. The south bulkhead piles were finally lowered into place by hammer blows — about 400 to the inch.

The District maintains channel depths of 14 feet between the Manasquan jetties and 12 feet to the R. R. Bridge over Manasquan River. Point Pleasant Canal, formerly Bay-head-Manasquan Canal, was developed by the State of New Jersey; it was completed in 1926 over the route originally surveyed in 1839 and resurveyed in 1879. Previously, between 1908 and 1916, the State had excavated over three million cubic yards of material from the bays and thorofares from Bay Head to Cape May Harbor, to provide a protected waterway six feet deep, 100 feet wide and 100 miles long. The final link in the New Jersey Intracoastal Waterway was created as a wartime emergency measure in 1942. The three-mile Cape May Canal, between Cape May Harbor and Delaware Bay, was dredged at federal cost, about 95 per-

cent of which was defrayed by Navy Department funds.

Federal control of the Waterway was urged by the State of New Jersey and by other public interests in the latter years of World War II. A study by the Corps of Engineers in 1938-39, recommending Federal Jurisdiction was the basis for a 1945 Congressional Act approving the transfer. Final conveyance to the United States was made in 1954.

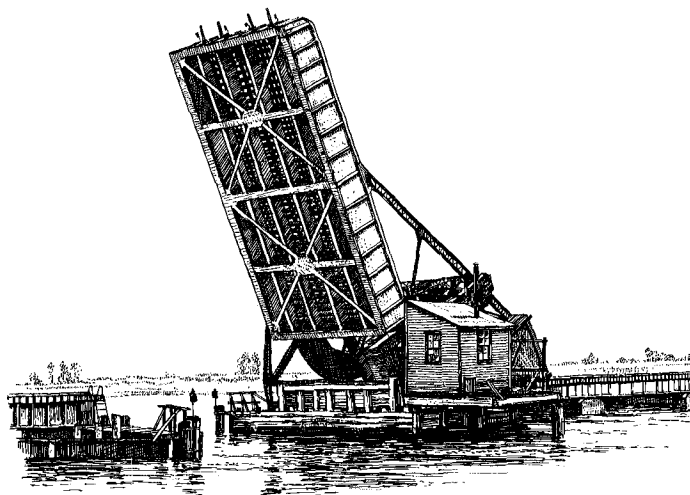
The channel is maintained at a six-foot depth for most of its length and follows a fairly tranquil course, except for a few open reaches exposed to sea conditions. The route passes under or through 26 bridges, of which four are fixed, six swing and 16 bascule. Operation of the movable spans is governed by Federal regulations. The District's maintenance operations account for the removal of approximately 194,200 cubic yards of material annually from the navigation channel.

The waterway serves hundreds of thousands of persons annually for pleasure boating, sport and commercial fishing. Continuing studies are exploring the expediency of increasing its depth and improving the channel alinement. Broad Thorofare, below Margate City, was improved in 1963 by the excavation of 150,000 cubic yards of material, providing a safer transit by bypassing Great Egg Harbor Inlet. Rehabilitation of bulkheads for the two-mile length of Point Pleasant Canal was begun in 1971; canalside walkways, access stairs and landscaping are in planning for this sector. A proposed project for Northern New Jersey would extend the inland channel above Manasquan by digging a 20-mile canal between the Manasquan and Shrewsbury

ivers. Reported to Congress in 1918, the project has not yet merited economic justification.

Parallel jetties guard the entrance to Cape May Canal at its western terminus in Delaware Bay; they were constructed in 1943 under the same authorization that funded the canal. In 1964, the south jetty was relocated 175 feet southward by the Delaware River and Bay Authority, to facilitate operation of its Cape May-Lewes ferry system. Under Department of the Army permit and at its own expense, the Authority further improved its bay crossing by channel dredging, construction of a stone breakwater at Lewes, Delaware, and construction of ferry terminals at Lewes and within the Cape May Canal entrance.

Leaving Cape May Canal, the Delaware Bay crossing is the next link in the Inland Waterway: about 17 miles to Roosevelt Inlet and access to the Lewes and Rehoboth Canal or nearly 59 miles to the Reedy Point entrance



Old railroad drawbridge across Manasquan River.

The saving basin on the north side of Chesapeake City Lock was modified to facilitate admittance into the canal of working craft too large to enter through the locks. In this view, adapted from an old photograph, a dipper dredge has entered the basin through the gated coffer dam at left. On the right, a large pipeline dredge is berthed under the north wall of the lock.

of the Chesapeake and Delaware Canal. The District's maintenance responsibilities extend westward from Reedy point about 25 miles to the C & D Canal approach channel in Chesapeake Bay and Elk River.

A New Freeway

The purchase of the Chesapeake and Delaware Canal by the United States Government was transacted on August 13, 1919. Its conversion to a sea level canal began with dry excavation by steam shovel on June 27, 1921. The reconstruction project was under direction of the Corps of Engineers with the District Engineer, Wilmington, Delaware in charge. The authorization provided for a channel depth of 12 feet and a bottom width of 90 feet. The route was to essentially follow that of the existing canal except at the eastern terminus. There a new entrance would be made at Reedy Point, two miles south of the old entrance at Delaware City.

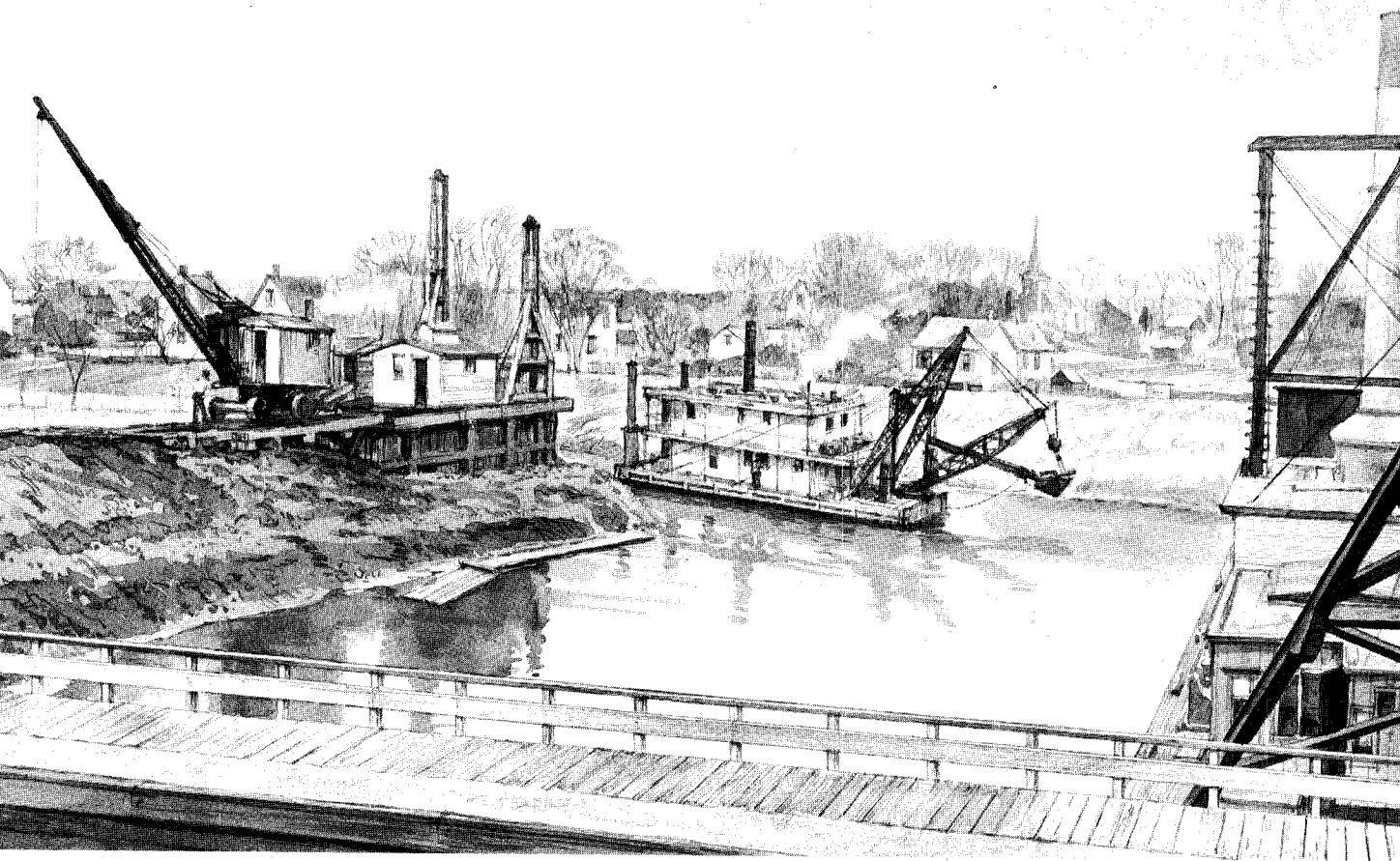
This deepening and widening operation was candidly conceived as a first step, the rather limited dimensions still not fulfilling the requirements of a ship channel. Specified for barge traffic, its plans anticipated further enlargement should such a course appear justified by a substantial increase in traffic. Piers for the five new vertical lift bridges were built deep enough to allow for a possible future channel depth of 35 feet. The bridges when open had a vertical clearance of 140 feet above low water and a clear span of 175 feet between fenders, except the Chesapeake City bridge, which had a horizontal clearance of 240 feet.

It was stipulated that work should proceed without interruption of water traffic, which

amounted to an estimated 30 to 50 vessels daily. This implied continued use of the locks and liftwheel pumping plant and imposed some restrictions on movement of the dredges, which were too large for the locks. Highway and railroad traffic using the bridges across the canal was to be interrupted as infrequently as possible. The problem of moving large dredges into the canal was solved by ingenious conversion of the saving basin at Chesapeake City to the function of a lock. Cofferdams of steel sheet piling were constructed on two sides of the basin. One of these was removed to admit the dredge at low tide. This cofferdam was then replaced, the basin flooded to canal level and the dredge floated through the opening made by removal of the second cofferdam. Six large dredges were moved in and out through this auxiliary lock. The working plant consisted of seven large hydraulic dredges, two scoop dredges, one steam shovel and two dragline banking machines.

As with the original canal, major problems were again encountered in excavating the Deep Cut. Here, the largest amount of material to be removed was concentrated, and bank slides made considerable excess dredging necessary. The summit Divide, through which the deepest excavation was made, averaged an elevation of 80 to 85 feet above sea level. Lifts of 80 to 95 feet were involved in removal of dredge material to disposal areas outside the channel cutting.

The locks at St. Georges and Chesapeake City were finally removed and the new channel was formally opened on May 14, 1927. The new entrance from the Delaware River at Reedy Point was protected by two



rubble-mound type jetties, each extending offshore 1,350 feet. The jetties were completed in 1929, at a cost of approximately \$350,000.

The estimated cost of converting the canal to a 12 foot depth was \$13,000,000; the actual cost \$10,060,000. The total amount of material excavated was 16 million cubic yards. During its last year of operation as a lock canal a total of 608,466 tons were carried. Annual tonnage figures for the next six years were:

1928 —	700,413
1929 —	709,095
1930 —	867,715
1931 —	990,940
1932 —	1,017,332
1933 —	1,191,242

Free of tolls and locks, the canal had become an attractive route for more freight lines, increasing its annual tonnage by nearly 100 percent in a half-dozen years. The upward trend indicated a growing demand for

access to the route and attested to the need for a deeper, wider channel to accommodate ship transit. In 1933, the Board of Engineers for Rivers and Harbors recommended that the channel be modified to a depth of 25 feet and a width of 250 feet. It was further recommended that a 400 foot wide channel be dredged from the mouth of Back Creek down Elk River and Chesapeake Bay to deep water near Pooles Island, an additional 26 miles.

Way for the Ships

In 1933 the Country was still reeling from the effects of the '29 market crash. The economy was in dire straits; many thousands could not find work and were on relief rolls. Initial funding for the new enlargement project was made under the Emergency Relief Appropriation Act in the amount of \$5,107,000. The purpose of the Act being to provide jobs for persons on relief, it was rigidly stipulated that 90 percent of all workers should be hired



Workmen employed under the Emergency Relief Appropriation Act moved earth with hand tools on the embankments of the Chesapeake and Delaware Canal.

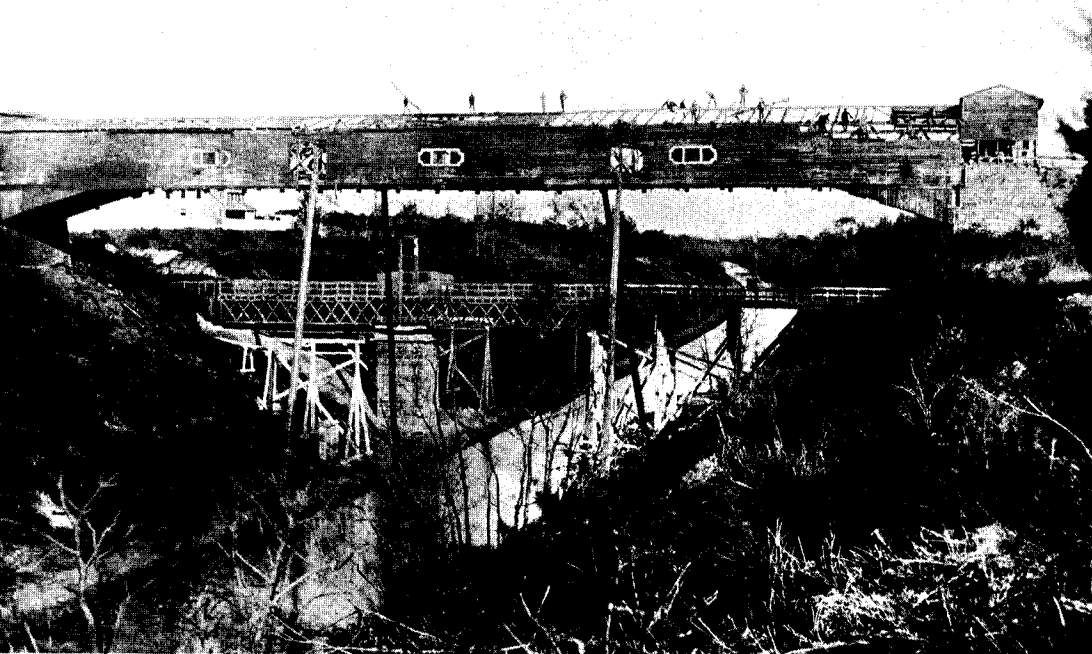
from relief rolls. The project was adopted in 1935 as recommended in the 1933 report, except that a revised depth of 27 feet was authorized. The work was under the direction of the District Engineer, Philadelphia District, except the 26 miles of channel from Elk River to deep water, which came under the jurisdiction of the Baltimore Engineer District.

Approximately 35 million cubic yards of material were excavated to produce the new channel, most of it pumped out by hydraulic dredges at the rate of one million cubic yards per month. A vast and varied array of equipment was engaged in the reconstruction project, headed by the powerful pipeline dredges: Baltimore, General, Orion, and Ventnor, of which the Baltimore was the largest and most modern. In addition there were steam shovels, draglines, elevating graders, diesel tractors, caterpillar wagons, euclid carry-alls, dump trucks and Le Tourneau scrapers. The removal of 4 million cubic yards of material by dry excavation was accomplished in the Deep Cut. Bank slides were minimized by this procedure, the overburden being removed down to the plane of

15 feet above mean low water before dredging was started.

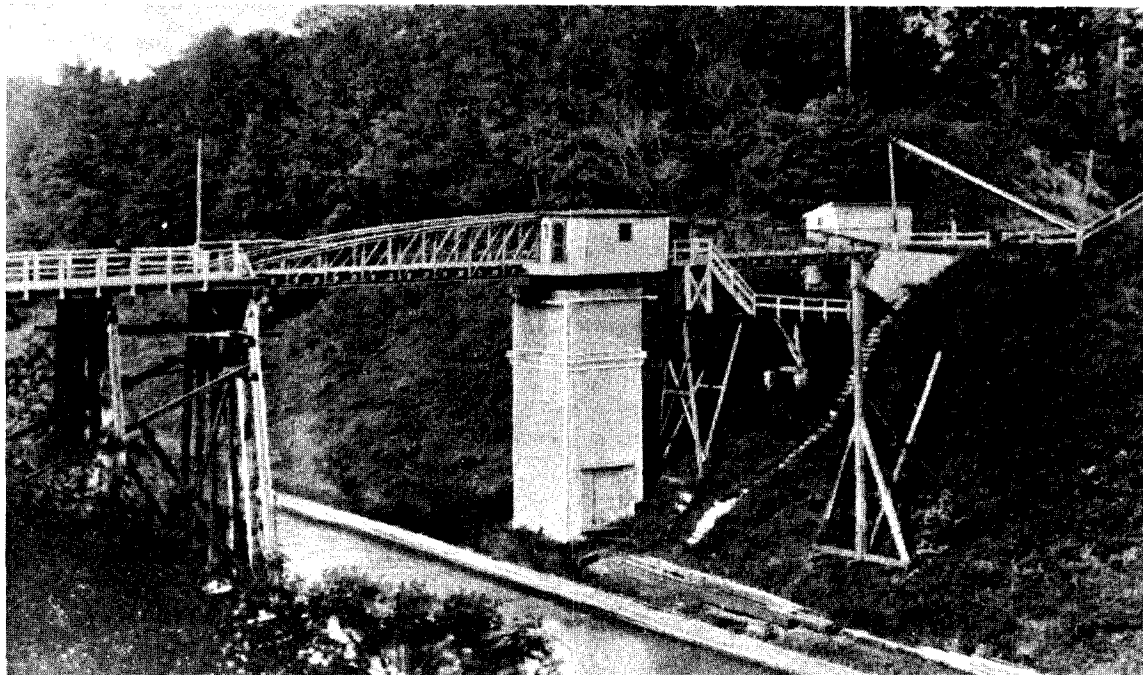
However, the slopes through the Summit Divide continued to prove unstable. The decision was reached to seek methods for preventing the recurrent slides. Studies were initiated at the Foundation Investigation Section at Ithaca, N.Y.⁸ and a laboratory was set up on the Engineer Reservation at Wilmington, Delaware to study bank soils. The results of these observations showed the need for flatter slopes than 1 on 2, more on the order of 1 on 5⁹. Relieving berms (ledges) were advised together with a drainage system to carry off ground water. A bank stabilization program was approved in April 1939. From 1940 to 1948 six and one half miles of embankment were graded and equipped with drainage facilities. The work required excavation of 4 million cubic yards of earth, installation of 10 miles of drainage pipe and placement of 56,000 tons of riprap at a cost of \$2,250,000.

The full channel prism was excavated at the bridges, requiring new shoreward spans and abutments. The existing bridge piers were



The original Summit Bridge was built in 1826 before the channel cutting was made. It spanned the canal across the "Deep Cut," 247 feet between abutments, 90 feet above the canal bottom. In this 1872 photograph the first Summit Bridge is being dismantled and its replacement is nearing completion just beyond.

Summit Bridge No. 2 was this pivoting span, located a short distance eastward of the old covered bridge site. Also known as Buck Bridge, the structure was in service 55 years before giving way to the canal enlargement project of 1921-1927.



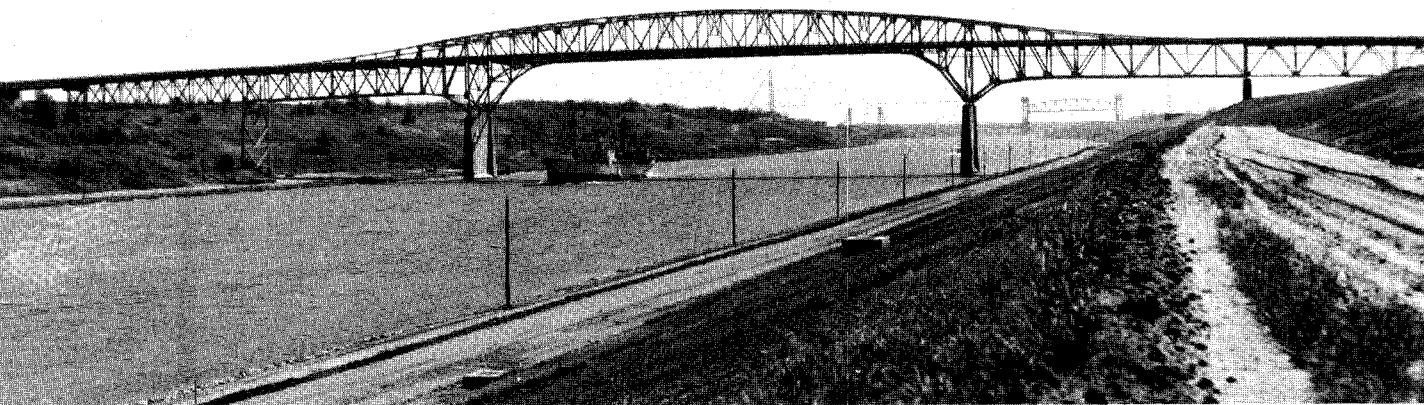
reinforced by driving steel pipe batter piles vertically around them. The piles were then filled with concrete and topped with concrete collars. A model study was made to seek remedies for the rapid shoaling which was occurring between the jetties at Reedy Point. The Waterways Experiment Station report concluded that shoaling could be reduced by

extending the north jetty. This was accomplished in 1942, when the north jetty was extended 800 feet.

Dredging the 26-mile approach channel in Elk River and Chesapeake Bay started on July 21, 1936. The work was directed by the District Engineer, Baltimore District using the Corps of Engineers' Hopper Dredges Nave-



The third bridge at Summit, Delaware was a vertical lift iron bridge with a horizontal clearance of 190 feet between piers and 140-foot vertical clearance at mean low water, span up. Its design was similar to that of four other lift bridges, constructed when the Chesapeake and Delaware Canal was converted to a sea level waterway.



The high level Summit Bridge was opened to traffic in 1960. That year it received the "most beautiful bridge" award from the American Institute of Steel Construction. This fourth Summit Bridge spans the canal near the "Deep Cut" site of the original bridge, but the cut seems shallow with its terraced embankments and new width of 450 feet at the water line.

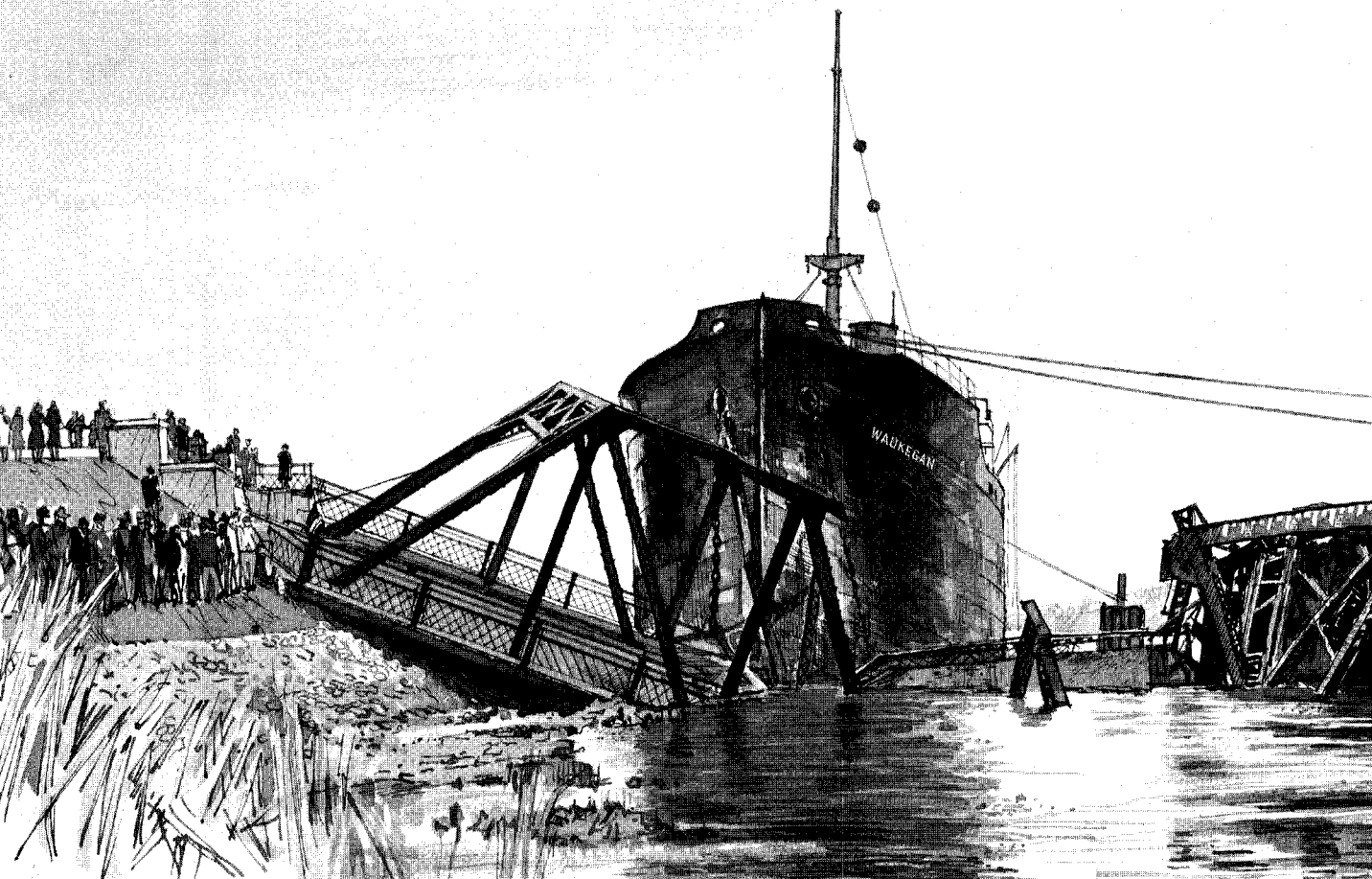
sink, Absecon, Atlantic and Delaware in the work. When dredging stopped on May 11, 1938 a channel 400 feet wide and 27 feet deep had been dug from the mouth of Back Creek in Elk River to a point in deep water southeast of Pooles Island in Chesapeake Bay. More than 24,315,920 cubic yards of material were removed, and deposited in specially-diked disposal areas contiguous to Pearce Creek. This 997 acre site at the mouth of Elk River had previously been purchased by the U. S. Government for the purpose. Tonnage figures soared from 1,061,207 tons in 1935 to 10,827,000 tons in 1942, from the middle of the 27-foot conversion period through the "Arsenal of Democracy" years into the first full year of United States engagement in World War II. That war-inflated figure remained the all-time peak for 22 years. It was topped in 1964 by the impressive total of 11,167,500 tons.

The 27-foot channel at last provided a ship-way across the Delmarva Peninsula, but not the final ship-way. Ocean-going vessels picked up pilots at canal's entrances, glided around the curves and edged cautiously between the piers of the steel bridges, not always successfully. There were scrapings, groundings and collisions. On Jan. 10, 1939 at about 8:30 A.M. the S.S. Waukegan, west-bound from Reedy Point, refused to answer the helm, sheered north and struck St. Georges bridge, completely demolishing that structure and killing the bridgetender and his assistant.

On a day of good weather, July 28, 1942, at 11:38 A.M. the 540-foot Motorship Franz Klasen with three towing vessels in attendance, approached Chesapeake City bridge from the eastward side. With a strong current running against her starboard bow, the vessel failed to make the proper maneuver in what



A merchant ship, bound for Philadelphia through the canal, passes under Chesapeake City bridge.



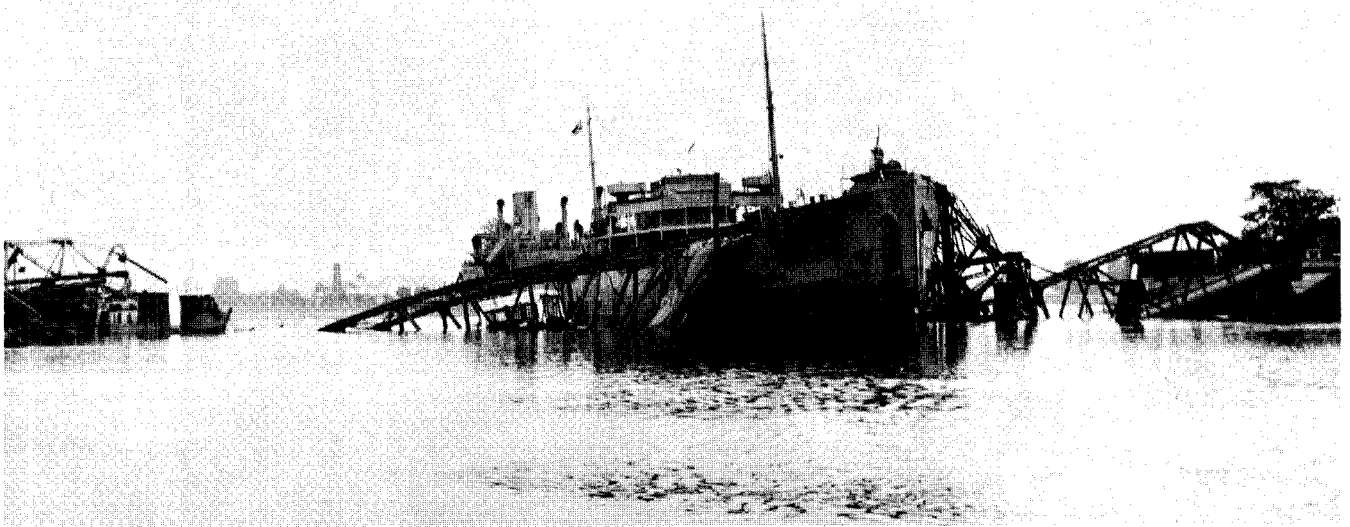
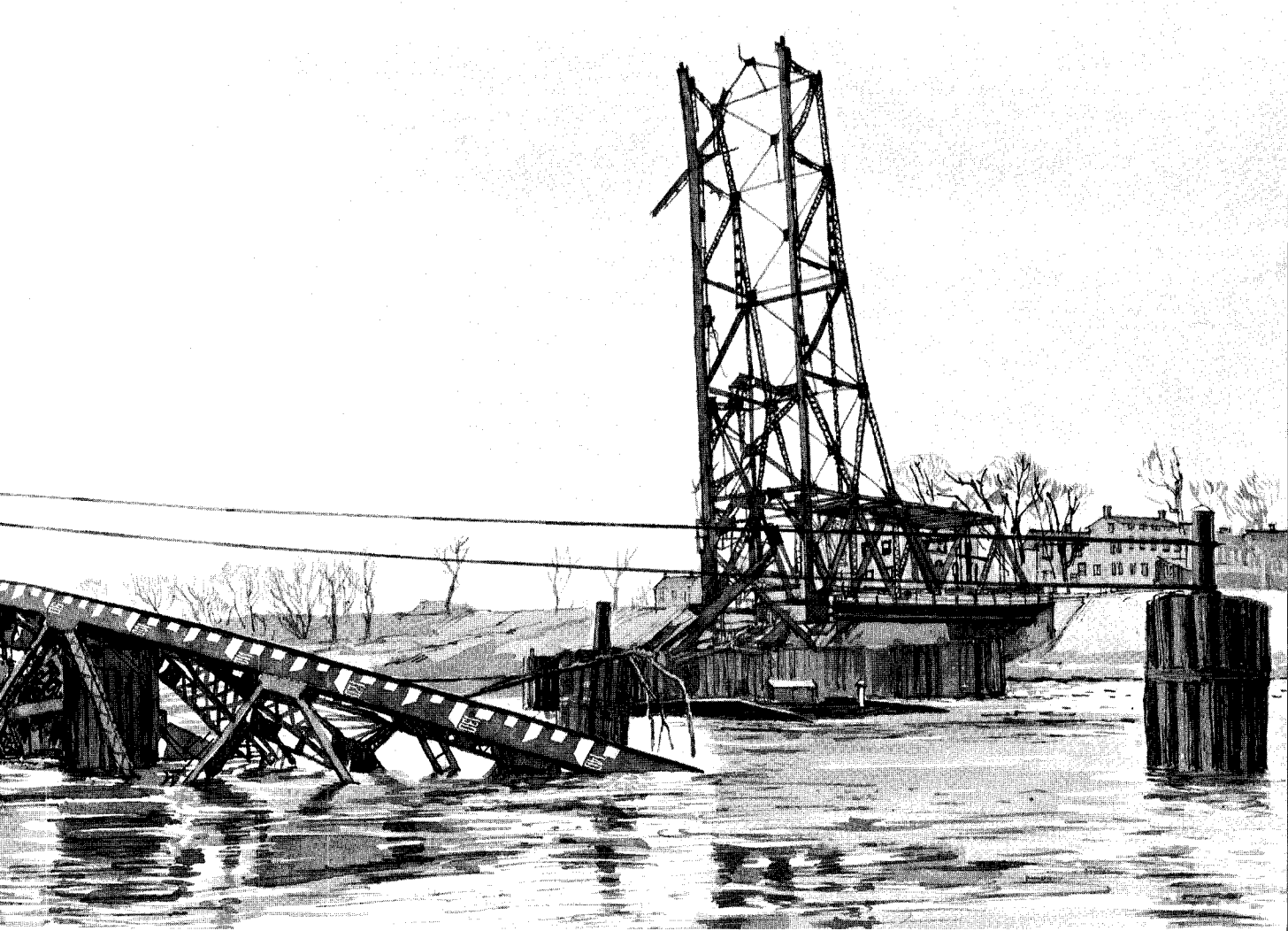
The S.S. Waukegan aground and jammed in the wreckage of St. Georges Bridge.

was then the middle of a 3,700-foot radius bend. Her sheer to port brought her against the south pier of the bridge and the impact crashed the lift span down across her bow. The bridge towers with their counterweights and the approach spans collapsed into the canal. No lives were lost.

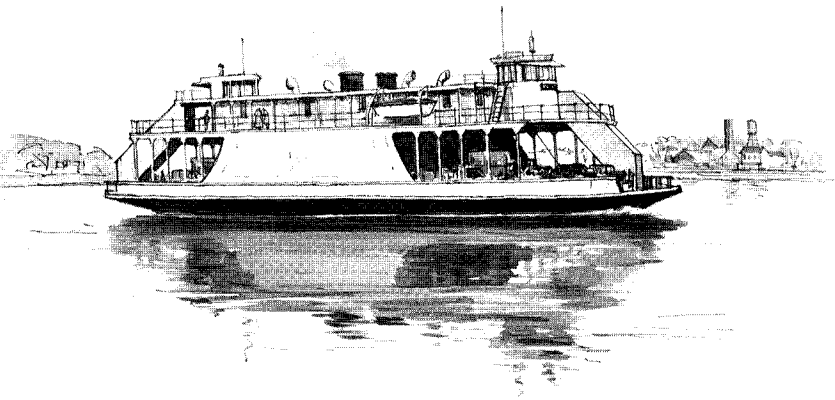
Interruption of highway traffic was remedied at both sites by the installation of a ferry service, which operated while the bridges were being replaced. The new St. Georges bridge, a single span tied arch structure carrying a four-lane highway was opened to traffic on 31 Jan. 1942. Chesapeake City's new high level bridge of similar construction was built between 1946 and 1949. Longer hulls with deeper drafts and broader beams sought access to this convenient short cut on the seaboard trade route. As before, the

arguments for change were supported by the most persuasive proof of the canal's usefulness: an increase in the number of transits and the amount of tonnage hauled. Serious consideration had to be given the depositions of pilots, crews and government personnel, taken in the increasingly frequent instances of ships' impacting with each other and with canal structures.

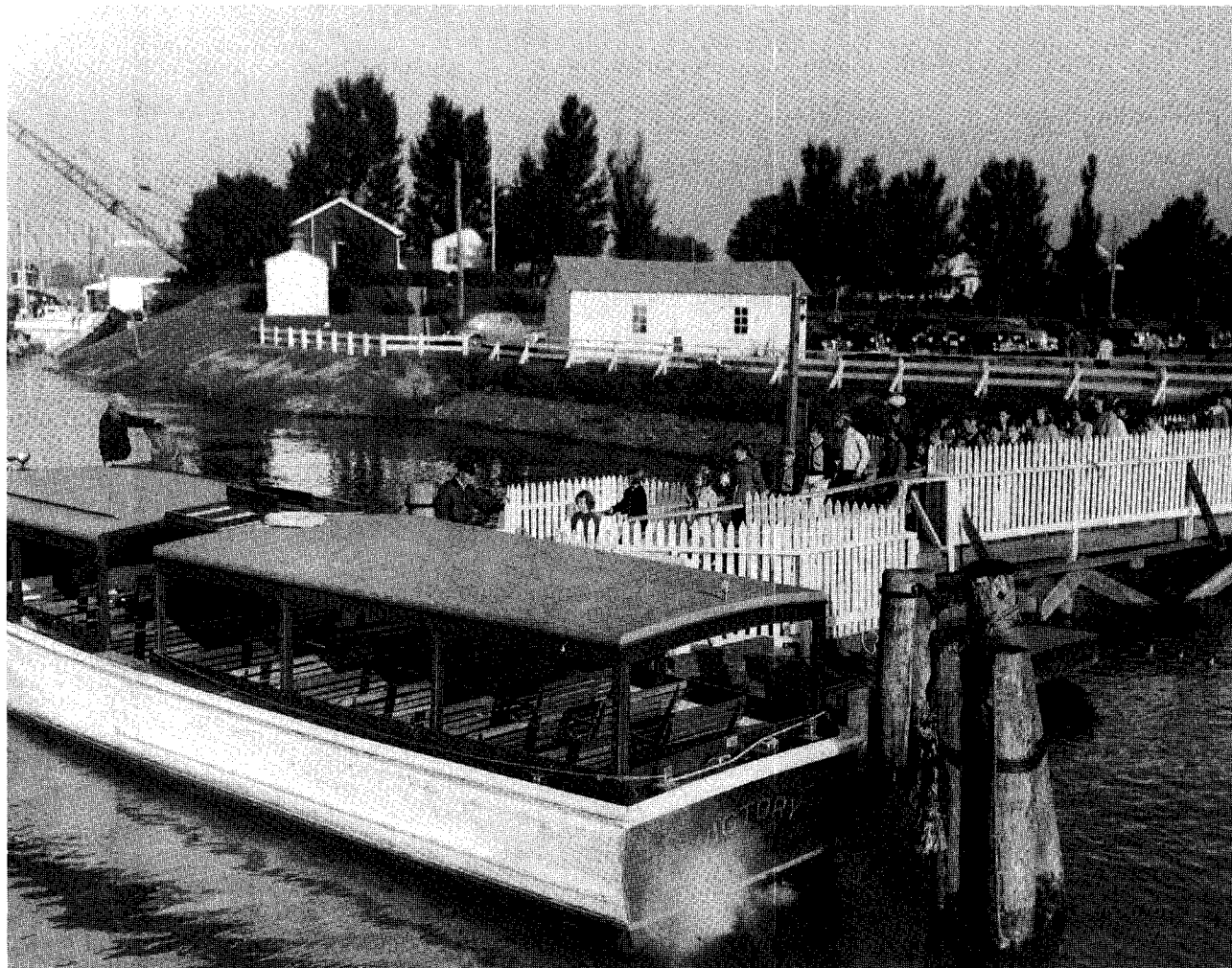
Resident Engineers' accident reports redundantly recommended a wider channel, elimination of curves and replacement of the narrow lift bridges with high level fixed spans. Responding to these needs, the studies in progress faced the inevitable dilemma: whether to make another interim change to satisfy current needs or to project a final ideal situation that would still be consistent with economic reality. Vessels transiting the canal



Franz Klasen with wrecked Chesapeake City Bridge.



Between late July and October of 1942 only pedestrian traffic crossed the canal at Chesapeake City. Vehicles had to detour about ten miles, using Summerville bridge. Of the several launches used initially for ferrying, one was named "Oakes" in recognition of the bridge tender, William F. Oakes, who was killed three years earlier in the collision which destroyed St. Georges bridge. The traffic situation was relieved when the Corps of Engineers installed ferry slips and put the 40-vehicle ferry boat "Gotham" on a 24-hour toll free schedule. This service was discontinued on September 21, 1949, after completion of the new high-level bridge.



The population of Chesapeake City, Maryland numbered 2,301 in the 1940 census, about evenly divided between north and south. Destruction of the bridge caused considerable disruption of community life. The fire house was on the north side of the canal; schools were on the south side. Interim ferry service

for pedestrians was provided immediately by the Government in the form of various Corps-owned launches. A leased motor cruiser, the "Victory," began service on September 15, 1942 and ferried approximately 1,850 persons daily during her 39-day lease. Here, school children are boarding at the north side.



Nearing completion in this 1968 view is the cut-off channel with new railroad lift bridge. This improvement eliminates the navigational hazards of Lorewood curve and the narrow span at left.

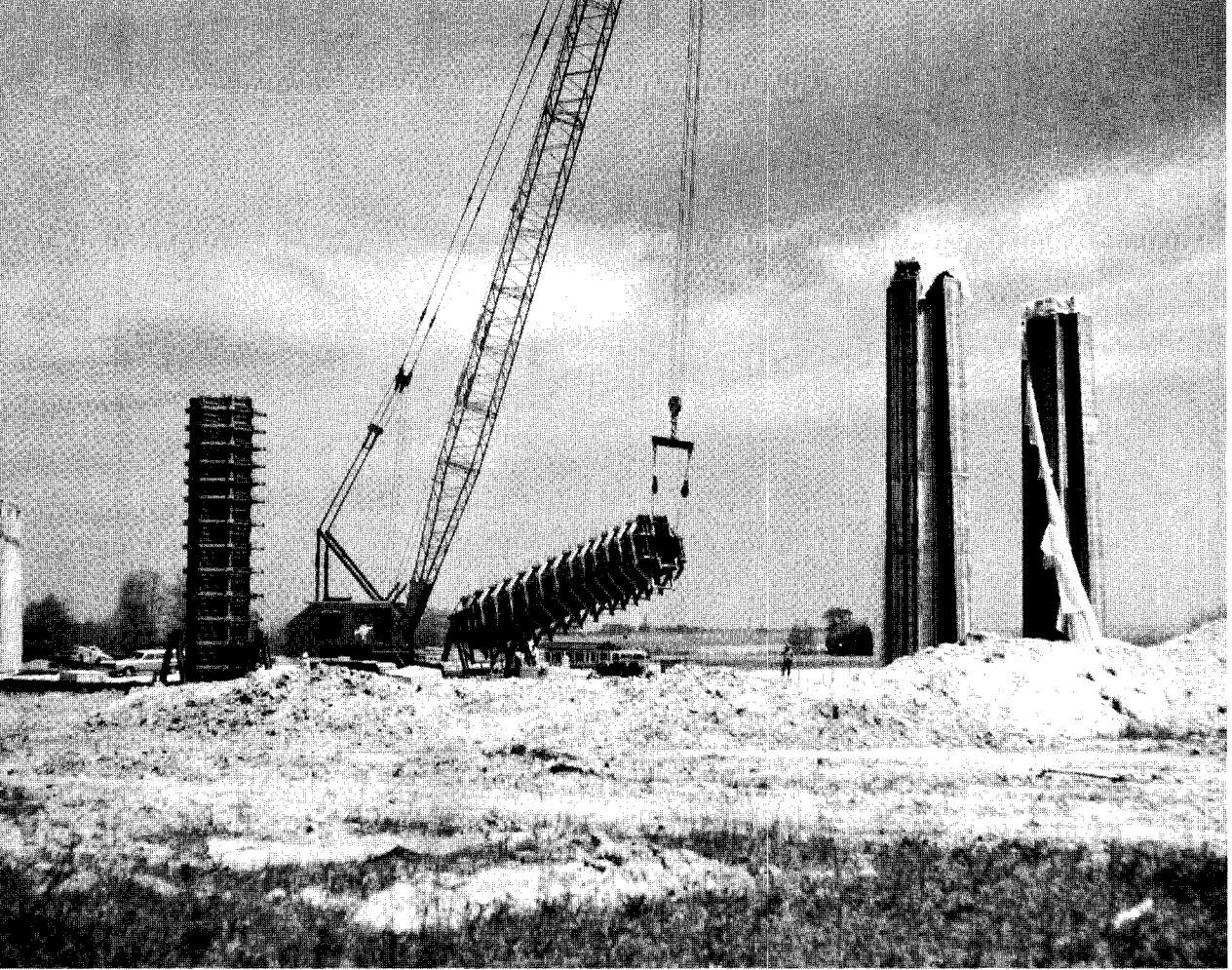
averaged a beam width of 62 feet, with a maximum permissible width of 72 feet and length of 540 feet respectively. An ultimate prism formula was determined after studying Panama Canal figures for passing distances and ascertaining the fact that most passages on the C & D were partially loaded vessels taking on or discharging cargo between the ports of Baltimore, Philadelphia and New York. It was additionally determined that:

"the width of canal that would be required to keep the forces of interaction between large vessels, and between vessels and the banks down to negligible magnitude would be so great as to be impossible of economic justification."

This seemed to suggest that limiting criteria were needed to regulate admissible hull sizes and the movement of traffic. Such considerations were inherent in the establishment of ultimate channel dimensions and fixed bridge clearances.

The Final Touches

Major studies were completed in 1954, with the Congress authorizing further improvements to the canal in that year. First of the improvements was a four-lane high-level highway bridge at Summit, Delaware to replace the 32-year old iron lift bridge. This new Summit Bridge, begun in 1958 and opened to traffic in 1960 is the fourth to be constructed at the high point of the Deep Cut divide. Before the lift bridge there had been a pivot swing bridge, built in 1867 to replace a high-level wooden covered span. High priority was given to easing the severest curves, especially those at the railroad bridge and at Chesapeake City. No bend was to have a curvature radius of less than 7,000 feet. The new channel was to be 35 feet deep at mean low tide with a bottom width of 450 feet. The hazardous Lorewood curve at the railroad bridge was by-passed by a straight cut-off channel 1,400 feet to the south. A new vertical lift bridge with a span of 500 feet

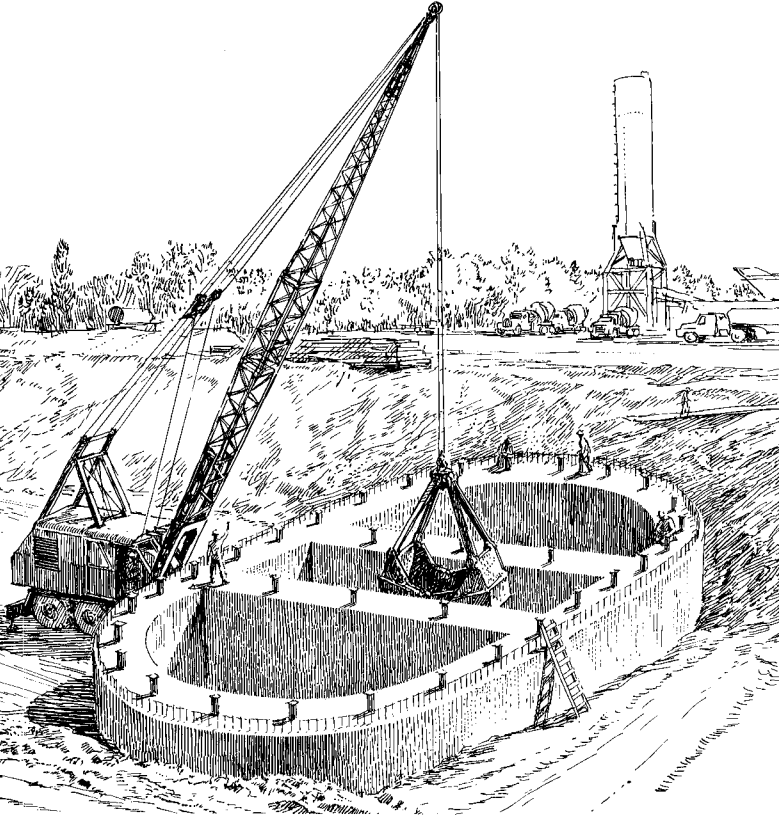


Construction of piers for Reedy Point high level bridge.

would carry the Penn Central tracks across the straightened channel.

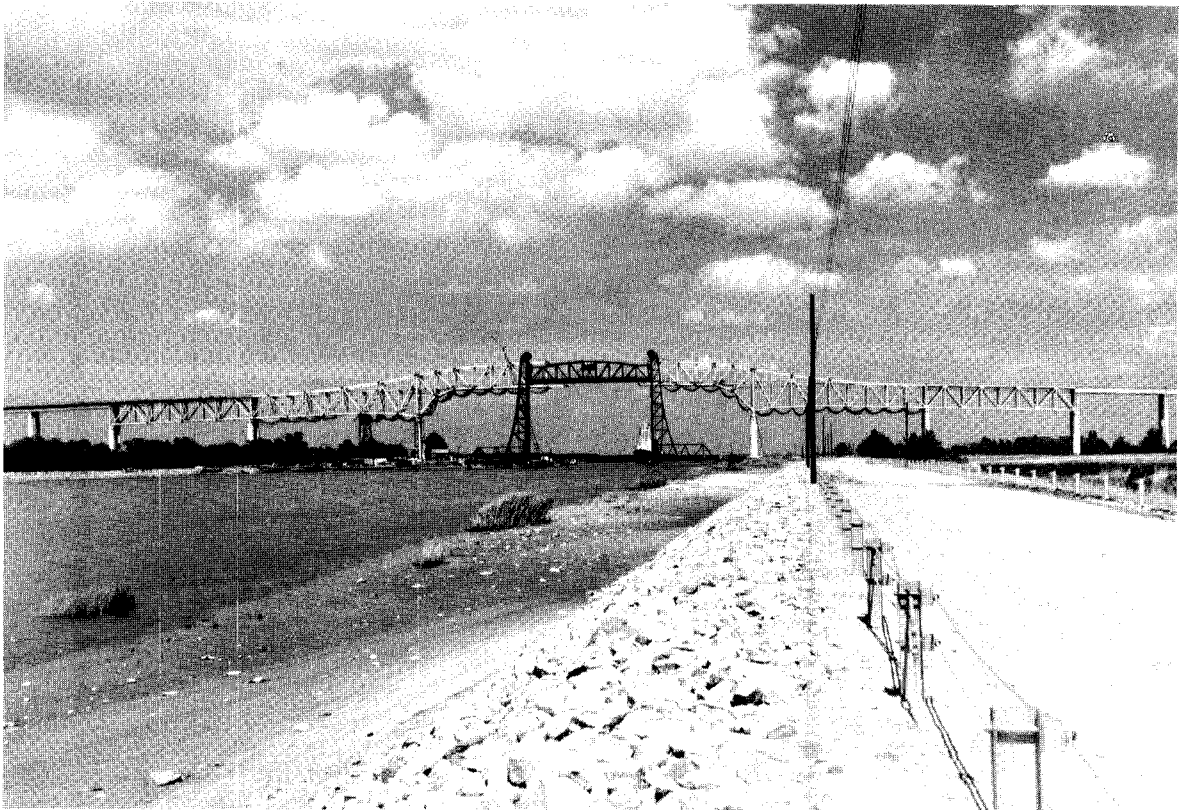
With the construction of a high-level highway bridge at Reedy Point, all of the old lift bridges except the railroad bridge have been replaced with fixed spans. Reedy Point Bridge was officially opened on 23 November, 1968 after three years of construction. A total length of nearly two miles was required to achieve the necessary vertical clearance and maintain a tolerable three percent road grade. Piles were driven for 31 piers on the north approach and 33 piers on the south, across the tidal plain. Caissons for the two main piers were lowered through sand, clay, and gravel to a depth of 80 feet below ground surface. The 600-foot through-truss cantilever span carries a four-lane highway across the canal with a vertical clearance of 135 feet above mean high water.

The improvement plan provides for stabilization of the banks by grading, seeding and drainage. A stone revetment was installed on the banks between high and low extremes of tide level and lighting was provided along both banks for the entire length of the canal proper. As of Spring 1970, dredging was continuing to complete the channel to a new controlling depth of 35 feet. Contracts were being negotiated for removal of the old lift bridges at Reedy Point and Lorewood Curve which, though replaced, were still traffic hazards. Contracts were then in preparation for removal of the south jetty at Reedy Point and construction of a new jetty farther south. Other phases of the Plan of Improvement provided for the planting of a variety of trees and shrubs, and for the installation of recreation areas at Reedy Point and Welch Point, with facilities for swimming, boating, fishing, and picnicking.



Sinking a caisson for Reedy Point Bridge

Material was elevated by clamshell through the dredge wells and hauled away in dump trucks. A batch plant, installed at the work site, was capable of producing sufficient good mix for the maximum pour to be made in an eight-hour day. Maximum pour was the caisson cap.



Old and new bridges at Reedy Point. The vertical lift span, in up position, seems to fill in the incomplete center span of its unfinished high level replacement beyond.